

REMARKS/ARGUMENT

Claims 14-21 and 33-40 are pending after entry of this Amendment.

Rejections under 35 USC §112

Claims 37-40 were rejected under 35 USC §112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which Applicants regard as the invention. According to the Office, the term "high aspect ratio" in claim 37 is a relative term which renders the claim indefinite. Applicants respectfully traverse this rejection and request reconsideration.

"High aspect ratio" is a term of art that is well known and understood by one of ordinary skill in the art. Exemplary of the common usage and understanding of the term is the patent to Tomita et al. (U.S. Patent No. 5,593,540), cited by Examiner. In Tomita et al., the term high aspect ratio is used in the Background of the Invention section at col. 1, lines 36-38, "An anisotropic etching having a high aspect ratio is utilized for the manufacture of a semiconductor device having a finer pattern." Compare this to Applicants' use of high aspect ratio in the Background of the Invention of the instant application: "As the demand to etch smaller and smaller integrated circuit device patterns continues to increase, more difficult high aspect ratio etching will be needed" (page 3, lines 22-23). Applicants further describe high aspect ratio in relation to etch geometry at page 4, lines 4-6: "As the aspect ratios continue to increase (*i.e.*, deeper and narrower etching geometries), a process window that defines a set of controllable process parameters will also rapidly shrink." And, according to Tomita et al., "For achieving an anisotropic etching with a high aspect ratio, it is necessary to set the inner pressure of the process chamber at a low level, leading to a plasma polymerization of the treating gas" (col. 1, lines 38-41).

Tomita et al. further describe, and illustrate, high aspect ratio at col. 5, lines 60-64: "FIG. 8 is a cross sectional view showing a wafer etched with a high aspect ratio. It is seen that the wafer is etched uniformly both in the central portion and in the peripheral portion." Applicants respectfully submit that the term high aspect ratio is well known in

the field, commonly used by one of ordinary skill in the art, and sufficiently understood by one of ordinary skill in the art to reasonably comprehend the scope of the invention. Applicants therefore respectfully request that the §112 rejection be withdrawn.

Rejections under 35 USC §103

Claims 33-35, 37-38, and 40 were rejected under 35 USC §103(a) as being unpatentable over Tomita et al. in view of admitted prior art. Applicants respectfully traverse this rejection, and request reconsideration.

Tomita et al. disclose a plasma etching system including a process chamber for enclosing a plasma, and a means for evacuation of the plasma from the chamber. A substrate is supported on a chuck electrode, and a shower electrode is positioned facing the chuck electrode. The shower electrode has a plurality of small holes. A power source is provided to strike a plasma between the chuck electrode and the shower electrode. Plasma forming gases are supplied through the small holes into the space between the chuck electrode and the shower electrode. The gas is supplied through the small holes at a mass flow rate of at least 620 kg/m²/hr.

Applicants' independent claim 33 claims a method of processing a semiconductor wafer. The method includes providing a processing chamber. The processing chamber is in an operational state and includes a top electrode, a wafer support chuck that has the semiconductor wafer positioned thereon, and a pair of RF power sources. The method then includes striking a plasma within a plasma region of the processing chamber, and causing a first surface of a plasma sheath to shift into electrode openings of the top electrode. The plasma sheath defines the first surface of the plasma sheath next to the top electrode and a second surface of the plasma sheath over a surface of the semiconductor wafer.

Applicants' independent claim 37 claims a method for high aspect ratio semiconductor etching. The method includes providing a plasma etch processing chamber which includes a top electrode, a wafer support chuck, and a pair of RF power supplies, and is configured in an operational state. A plasma is struck in a plasma region of the chamber. The plasma region is defined between an electrode surface of the top

electrode and a wafer surface of a wafer which is positioned on the wafer support chuck. A first surface of a plasma sheath which is proximate to the top electrode is caused to shift into electrode openings of the top electrode. A bias voltage over the wafer surface is increased while the bias voltage over the electrode surface of the top electrode is decreased without increasing a plasma density.

To establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine the reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art references when combined must teach or suggest all the claim limitations. (MPEP §2143). Applicants respectfully submit the Office has failed to establish a *prima facie* case of obviousness.

According to the Office, Tomita et al. teach, among other features claimed by Applicants, generating an increase in bias voltage/ion bombardment energy directed at a wafer surface of a semiconductor wafer surface W and a decrease in bias voltage directed at the top electrode 2, and further, that “inherently the plasma sheath will form within the inlet openings 55 to form the second plasma sheath surface area since the openings have an opening diameter of 0.6mm (see Applicants’ specification at page 13, lines 22-24 and column 5, lines 3-5 of Tomita et al.).” Applicants respectfully submit that neither the characteristics attributed to the reference nor the asserted inherency are supported, and that the Office has failed to establish a *prima facie* case of obviousness.

Regarding the Tomita et al. reference, there is simply no basis in the reference to suggest that the reference teaches the generating of an increase in bias voltage/ion bombardment energy directed at a wafer surface. The Office supports the assertion with a blanket citation to col. 3, line 40-col. 5, line 60, but fails to specify where in the citation the asserted disclosure exists. Applicants have reviewed the cited reference, and have failed to find such a disclosure. On the contrary, the cited section of the reference teaches nothing of ion bombardment energy, and instead teach increasing the flow rate of the plasma forming gases (col. 5, lines 39-43), and noting that “if plasma-forming gas flows at a high speed, plasma is generated uniformly” (col. 5, lines 53-54). As already noted,

Applicants are claiming the forming of a plasma sheath shifted into the electrode openings causing a disparity in surface areas between a first and second plasma sheath surface area, thereby increasing the ion bombardment directed at the wafer surface. Tomita et al. simply do not teach these features.

The assertion that it is inherent that the plasma sheath will form within the inlet openings 55 to form the second plasma sheath surface area since the openings have an opening diameter of 0.6mm is incorrect. "In relying upon the theory of inherency, the examiner must provide a basis in fact and/or technical reasoning to reasonably support the determination that the allegedly inherent characteristic necessarily flows from the teachings of the applied prior art" (MPEP §2112). Not only has the Office failed to provide the basis in fact and/or technical reasoning necessary, Applicants respectfully submit that the Office would be unable to do so using the cited reference.

While the Tomita et al. apparatus does include small holes 55 formed in the cathode plate 54 of a sufficient size (0.6mm) that plasma might be capable of flowing into the small holes 55 absent any other structural characteristics, the Tomita et al. apparatus is constructed in such a manner as to prevent such plasma flow, and Tomita et al. teach away from any possibility of such plasma flow. As illustrated in Figure 4, and described at col. 5, lines 14-20, the Tomita et al. apparatus includes a small hole 55b formed in the cathode plate 54 which is smaller than a small hole 55a formed in the cooling plate 53. Gas flowing through the small hole 55 as taught by Tomita et al. effectively prevents the plasma formed between the chuck electrode and the shower electrode from flowing back up into the small hole 55, or shifting into the small hole 55.

Compare the Tomita et al. structure to the structure described and claimed by the Applicants' to best illustrate why the Tomita et al. structure does not and cannot operate in the manner as claimed in Applicants' method claims. Applicants Figures 2A-2E illustrate the structural differences. Electrode openings 202b are *larger* than gas feed holes 228. When a plasma sheath is formed in the chamber, the dynamics of plasma flow allows for the surface of the plasma sheath to shift into the electrode openings, and thereby increase the surface area of the plasma sheath next to the upper electrode. Because the Tomita et al. structure has small holes 55b which are smaller than small

holes 55a, the plasma formed remains uniform in size, surface area, and density, within the chamber and cannot flow back through or into small holes 55b. Therefore, it is not inherent that the plasma sheath will form within the inlet openings 55 as asserted by the Office.

For at least the above reasons, Applicants submit that independent claims 33 and 37 are patentable over Tomita et al. in view of admitted prior art under 35 USC §103(a). Dependent claims 34-35, 38, and 40, each of which depends directly or indirectly from one of independent claims 33 and 37 are patentable for at least the same reasons. Applicants therefore respectfully request the §103 rejection be withdrawn.

Claims 14-21, 36, and 39 were rejected under 35 USC §103(a) as being unpatentable over Tomita et al. in view of Admitted prior art as applied above with respect to claims 33-35, 37-38, and 40, and further in view of Chang et al. (U.S. Patent No. 4,854,263). Applicants respectfully traverse this rejection, and request reconsideration.

Applicants' independent claims 33 and 37 are described above. Applicants' independent claim 14 claims a method for processing a semiconductor wafer through plasma etching operations. In a chamber for processing a semiconductor wafer through plasma etching operations, the chamber being in an operational state and including a support chuck for holding the semiconductor wafer, a pair of RF power sources, and a top electrode, the method for processing a semiconductor wafer through plasma etching operations includes striking a plasma in a plasma region of the chamber, and generating an increase in bias voltage directed at a wafer surface of the semiconductor wafer and a decrease in bias voltage directed at the top electrode. The top electrode is claimed as having a center region, a first surface and a second surface. The first surface has an inlet that is configured to receive processing gases from a source that is external to the chamber, and to flow the processing gases into the center region. The second surface has a plurality of gas feed holes that lead to a plurality of electrode openings. The plurality of electrode openings have electrode opening diameters that are greater than gas feed hole diameters of the plurality of gas feed holes. The plurality of electrode openings are configured to define the second surface which is located over the wafer surface of the

semiconductor wafer. When a plasma is struck in the plasma region defined between the second surface and the wafer surface, the plasma defines a first plasma sheath surface that has a first plasma sheath surface area that is proximate to the wafer surface, and a second plasma sheath surface that has a second plasma sheath surface area that is proximate to the second surface. The second plasma sheath surface area is greater than the first plasma sheath surface area.

Contrary to the Office's assertion that the Tomita et al. reference fails to expressly disclose where the electrode opening diameters are greater than the gas hole feed diameters, Tomita et al. illustrate in Figure 4, and describe in the associated text (see col. 5, lines 14-20) that a small hole 55b formed in the cathode plate 54 which is smaller than a small hole 55a formed in the cooling plate 53. If the Tomita et al. structure were to be modified in accordance with the electrode and gas feed openings as taught by Chang et al., the principle of operation of the Tomita et al. apparatus would be changed in such a manner as to render the Tomita et al. apparatus ineffective or inoperable for its intended purpose. In accordance with MPEP §2143, such a change in the principle of operation is insufficient to render the claims *prima facie* obvious.

Tomita et al. disclose an apparatus and structure to **prevent** plasma from flowing into the small holes 55b. As stated at col. 2, lines 46-52, "The particular gas supply system employed in the present invention permits suppressing the plasma polymerization within the small holes, with the result that a polymer is unlikely to be deposited on the circumferential wall of the small hole. Even if a polymer is formed, the polymer is blown away by the gas stream flowing at a high speed." If the asserted combination would allow plasma flow into the small holes, then the polymerization formation sought to be prevented and overcome would be re-introduced. Similarly, in a re-formed electrode and gas feed hole structure as proposed, a primary principle of operation of the Tomita et al. structure is not only modified, but defeated. Although the Office asserts that such a combination would be obvious to enhance dissociation and reactivity of the gases, to do so would modify the principle of operation of the apparatus. Tomita et al. address gas dissociation and reactivity by use of buffer plates (as pointed out by the Examiner) and

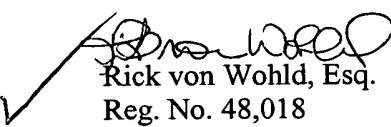
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baffle plate 50, and the increased flow rate of gases through the small holes 55, disclosed to be at a minimum of 620 kg/m²/hr.

The asserted combination at least fails to teach all the claim limitations, and fails to establish a requisite motivation for combination since the combination would change the principle of operation of the Tomita et al. apparatus. Applicants therefore submit that independent claims 14, 33, and 37 are patentable under 35 USC §103(a) over Tomita et al. in view of admitted prior art and further in view of Chang et al. for at least the above reasons. Dependent claims 15-21, 36, and 39, each of which depends directly or indirectly from one of independent claims 14, 33, and 37 are likewise patentable for at least the same reasons. Applicants respectfully request the §103 rejection be withdrawn.

In view of the foregoing, Applicants respectfully request reconsideration of claims 14-21 and 33-40. Applicants submit that all claims are in condition for allowance. Accordingly, a notice of allowance is respectfully requested. If Examiner has any questions concerning the present Amendment, the Examiner is kindly requested to contact the undersigned at (408) 749-6900, ext. 6905. If any additional fees are due in connection with filing this amendment, the Commissioner is also authorized to charge Deposit Account No. 50-0805 (Order No. LAM1P077A). A copy of the transmittal is enclosed for this purpose.

Respectfully submitted,
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